

TAXONOMIC SIGNIFICANCE OF EPIPHALLUS IN SOME INDIAN GRASSHOPPERS (ORTHOPTERA: ACRIDIDAE)¹

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(With five text-figures)

Key words: Epiphallus, Orthoptera, Acrididae, taxonomy

The present study comprises of the comparative descriptions and illustrations of epiphalli in 46 species representing 22 genera under 15 tribes belonging to three subfamilies of the family Acrididae. The significance of epiphallus in taxonomy is also discussed.

INTRODUCTION

The epiphallus (Fig. 5) is a strongly sclerotised isolated sclerite located on the dorsal surface of the phallic organ that serves to grasp the edge of the female subgenital plate and to fix the phallus firmly during copulation. Dirsh (1956) emphasised the importance of epiphallus in the classification of Acrididae. Further important contributions on epiphallus have been made by Eades *et al.* (1974), Harz (1975), Kevan and Chen (1969) and Kevan *et al.* (1970, 1971, 1972, 1974, 1975). Moreover, Meinodas (1986), Roberts (1941) and Usmani and Shafee (1983) have confirmed the stability and reliability of different parts of the epiphallus in the higher classification of Acrididae.

MATERIAL AND METHODS

To study the epiphallus the apical portion of the abdominal region of preserved male grasshoppers was removed and boiled in a test tube containing 10% KOH solution till the muscles dissolved completely. After washing thoroughly in water, it was dissected under binocular microscope with the help of fine needles to separate the epiphallus. After dehydration in

different grades of alcohol, clearing was done in clove oil. The epiphallus was mounted on slides in dorsal view in Canada balsam. The slides were kept in an oven at approximately 40°C for a few days to dry. Drawings were made with the help of camera lucida.

DESCRIPTION

Subfamily Pyrgomorphae Tribe Pyrgomorphini

Pyrgomorpha conica (Oliver) (Fig. 1A): Bridge of epiphallus broad; lateral plates with anterior processes slightly developed, posterior processes well developed and directed outwardly, each bearing a small conical upward curving projection; dorsolateral appendages narrow at base, gradually broadened apically; ancorae and lophi absent.

Pyrgomorpha brachycera Kirby (Fig. 1B): Same as in *P. conica* except lateral plates with anterior processes indistinct, curved apical part of posterior processes long; dorsolateral appendages much broadened apically.

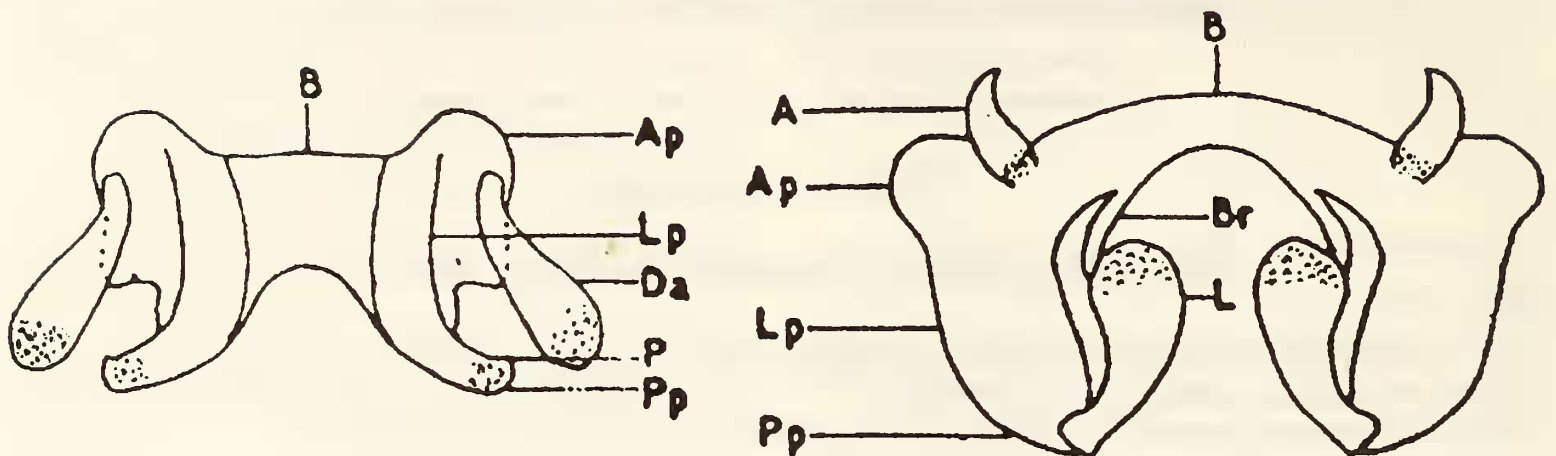
Tribe Orthacridini

Neorthacris palnensis (Uvarov) (Fig. 1C): Bridge of epiphallus much broad; lateral plates with well developed anterior processes, posterior

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Epiphallus: Pyrgomorphae.

Epiphallus: Acridinae

Fig. 5. Parts of the epiphallus: A. ancorae; Ap. anterior processes; B. bridge; Br. branch of bridge; Da. Dorsolateral appendages; L. Lophi; Lp. Lateral plate; Pp. posterior processes; P. projection of posterior processes.

processes long and straight, each bearing a well developed upward curving conical projection; dorsolateral appendages narrow at base and broad at apex; ancorae and lophi absent.

Neorthacris acuticeps (Bolivar) (Fig. 1D): Bridge of epiphallus with posterior processes diverging, projections directed inwards.

Orthacris maindroni (Bolivar) (Fig. 1E): Bridge of epiphallus narrow with anterior processes well developed, about one half of posterior processes; projections of posterior processes directed outwards.

Tribe Poekilocerini

Poekilocerus pictus (Fabricius) (Fig. 1F): Bridge of epiphallus very narrow; lateral plates with anterior processes slightly developed, posterior processes straight, each bearing a well developed upward curving conical projection; dorsolateral appendages narrow at base and gradually broadened at apex; ancorae and lophi absent.

Tribe Taphronotini

Aularches miliaris (Linnaeus) (Fig. 1G):

Bridge of epiphallus narrow medially; lateral plates broadened with anterior processes well developed, posterior processes stout with upward curving conical projections; dorsolateral appendages narrow at base and gradually widened apically; ancorae and lophi absent.

Tribe Chrotogonini

Chrotogonus trachypterus (Blanchard) (Fig. 1H): Bridge of epiphallus uniformly narrow; lateral plates with anterior processes slightly developed, posterior processes triangular, directed outwardly and without projections; dorsolateral appendages narrow at base and abruptly rounded at apex; ancorae and lophi absent.

Tribe Atractomorphiini

Atractomorpha psittacina (Haan) (Fig. 1I): Epiphallus disc-shaped; anterior margin deeply notched in middle; posterior margin semicircular; lateral plates developed; dorsolateral appendages more or less uniform in width, slightly dilated in the middle; ancorae and lophi absent.

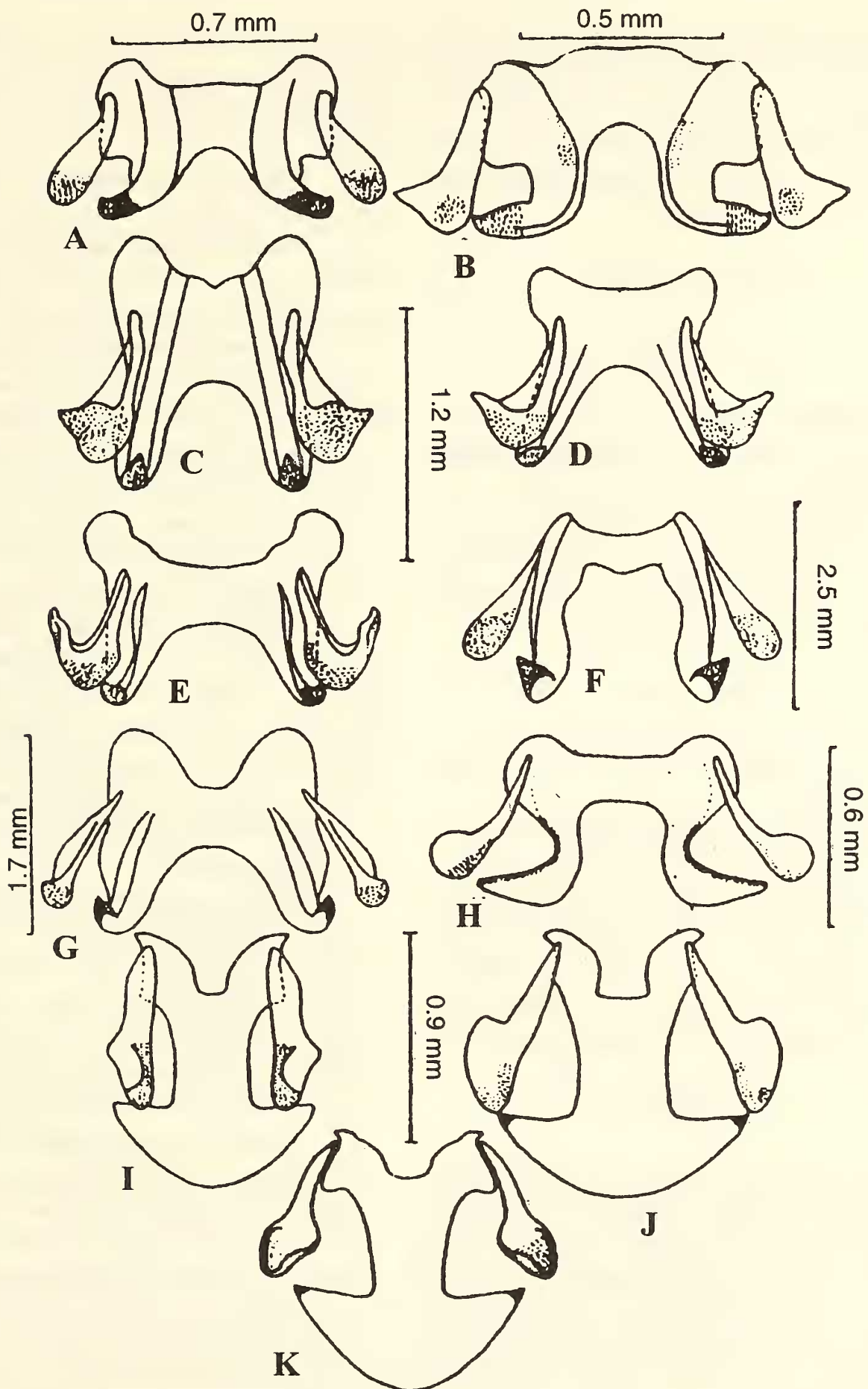


Fig. 1. Figs. (A-K): A. *Pyrgomorpha conica* (Oliver); B. *P. brachycera* Kirby; C. *Neorthacris palnensis* (Uvarov); D. *N. acuticeps* (Bolivar); E. *Orthacris maindroni* (Bolivar); F. *Poeciloceris pictus* (Fabricius); G. *Aularches miliaris* (Linnaeus); H. *Chrotogonus trachypterus* (Blanchard); I. *Atractomorpha psittacina* (Haan); J. *A. himalayica* Bolivar; K. *A. burri* Bolivar.

Atractomorpha himalayica Bolivar (Fig. 1J): Same as in *A. psittacina* except dorsolateral appendages broader at apex.

Atractomorpha burri Bolivar (Fig. 1K): Same as in *A. psittacina* except dorsolateral appendages which are spatulate.

Subfamily Acridinae

Tribe Truxalini

Truxalis eximia Eichwald (Fig. 2A): Bridge of epiphallus narrow in middle, posterior margin deeply concave; ancorae large, tooth-like, articulated with disc, distance between them about half the distance between posterior processes of lateral plates; outer lophi smaller than inner; dorsolateral appendages absent.

Tribe Acridini

Acrida exaltata (Walker) (Fig. 2B): same as in *T. eximia*.

Phlaeoba infumata Brunner (Fig. 2C): Bridge of epiphallus uniformly narrow, posterior margin deeply concave; ancorae well developed, slightly curved and pointed apically, distance between them more than half the distance between posterior processes of lateral plates; lophi lobe-like; dorsolateral appendages absent.

Tribe Locustini

Gastrimargus africanus (Saussure) (Fig. 2D): Bridge of epiphallus slightly narrow in the middle, posterior margin deeply concave, branches well developed; ancorae long and slightly curved, distance between them more than the distance between posterior processes of the lateral plates; lophi lobe-like; dorsolateral appendages absent.

Oedaleus abruptus (Thunberg) (Fig. 2E): Bridge of epiphallus uniformly narrow, posterior margin slightly concave, branches small and widely spaced; ancorae long, distance between

them about one half the distance between posterior processes of the lateral plates; lophi broadened in middle; dorsolateral appendages absent.

Oedaleus nigrofasciatus (De Geer) (Fig. 2F): Almost same as in *O. abruptus*.

Oedaleus senegalensis (Krauss) (Fig. 2G): Same as in *O. abruptus* except lophi which are much dilated, broadened apically.

Aiolopus simulatrix (Walker) (Fig. 2H): Bridge of epiphallus uniformly narrow, posterior margin semicircular, branches well developed and close to each other; ancorae large, distance between them more than half the distance between posterior processes of lateral plates; posterior processes of lateral plates curved inward; lophi sandal-shaped; dorsolateral appendages absent.

Trilophidia annulata (Thunberg) (Fig. 2I): Bridge of epiphallus uniformly narrow, posterior margin U-shaped, branches well developed and near each other; ancorae small and conical, distance between them half the distance between posterior processes of lateral plates; lophi well developed and almost triangular; dorsolateral appendages absent.

Locusta migratoria (Linnaeus) (Fig. 2J): Bridge of epiphallus uniformly broad, posterior margin V-shaped, branches well developed and close to each other; ancorae small, distance between them slightly more than half the distance between posterior processes of lateral plates; lophi lobe-like; dorsolateral appendages absent.

Acrotylus humbertianus Saussure (Fig. 2K): Bridge of epiphallus narrow in the middle with small branches; ancorae long and much curved; distance between them more than the distance between posterior processes of lateral plates; posterior processes of lateral plates with well developed inwardly directed projections; lophi lobiform; dorsolateral appendages absent.

Morphacris fasciata (Thunberg) (Fig. 2L): Bridge of epiphallus uniformly broad, posterior margin U-shaped, branches well developed; ancorae large, distance between them slightly smaller than the distance between posterior

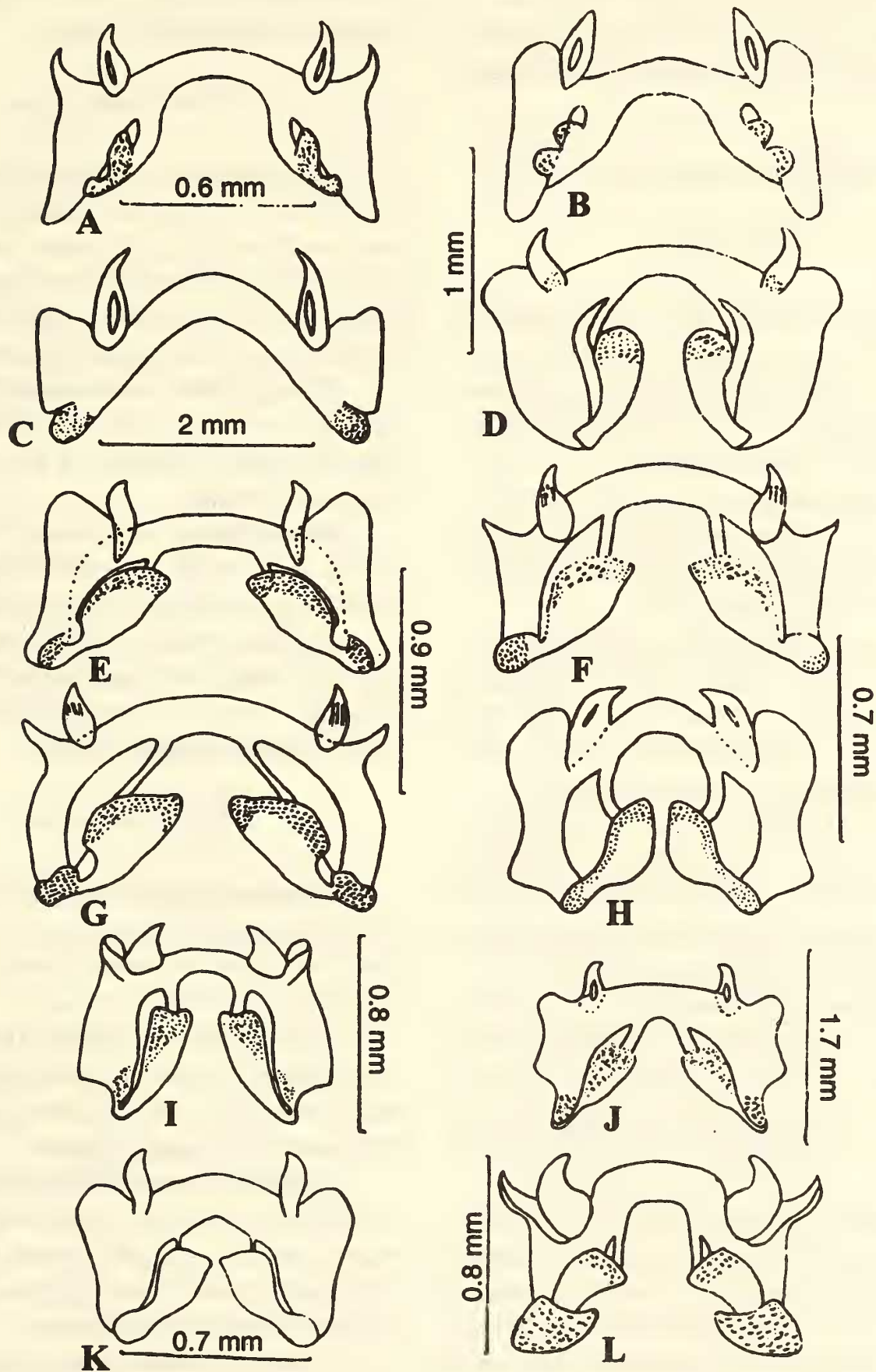


Fig. 2. Figs. (A-L): A. *Truxalis eximia* (Eichwald); B. *Acrida exaltata* (Walker); C. *Phlaeo infumata* Brunner; D. *Gastrimargus africanus* (Saussure); E. *Oedaleus abruptus* (Thunberg); F. *O. nigrofasciatus* (De Geer); G. *O. senegalensis* (Krauss); H. *Aiolopus simulatrix* (Walker); I. *Trilophidia annulata* (Thunberg); J. *Locusta migratoria* (Linnaeus); K. *Acrotylus humberianus* Saussure; L. *Morphacris fasciata* (Thunberg).

processes of lateral plates; posterior processes of lateral plates with well developed triangular projections; lophi broad; dorsolateral appendages absent.

Subfamily Catantopinae

Tribe Oxyini

Oxya hyla Serville (Fig. 3A): Bridge of epiphallus divided medially; ancorae absent; lateral plates small without anterior processes, posterior processes small; outer lophi tooth-like; dorsolateral appendages absent.

Oxya intricata (Stal) (Fig. 3B): Same as in *O. hyla*, except bridge of epiphallus with anterior margin medially having a triangular projection; outer lophi broad and plate like.

Oxya fuscovittata (Marschall) (Fig. 3C): Same as in *O. hyla*, except bridge of epiphallus widened medially; lateral plates with well developed anterior and posterior processes; outer lophi broad, plate-like, truncated apically.

Oxya chinensis (Thunberg) (Fig. 3D): Same as in *O. hyla*, except bridge of epiphallus widened medially; lateral plates with well developed anterior processes, posterior processes small; outer lophi triangular and twisted.

Oxya japonica (Thunberg) (Fig. 3E): Same as in *O. hyla*, except bridge of epiphallus broad; lateral plates with well developed anterior processes; outer lophi well developed and contiguous with posterior processes, blunt apically.

Oxya velox (Fabricius) (Fig. 3F): Same as in *O. hyla*, except bridge of epiphallus narrow medially; lateral plates with well developed anterior processes; outer lophi well developed and contiguous with posterior processes, inner lophi broadly triangular.

Gesonula punctifrons (Stal) (Fig. 3G): Bridge of epiphallus narrow, divided medially; ancorae absent; lateral plates with indistinct posterior processes, anterior processes well developed, having long transverse processes;

outer lophi toothlike, inner lophi lobe-like; dorsolateral appendages absent.

Tribe Hemiacidini

Hieroglyphus banian (Fabricius) (Fig. 3H): Bridge of epiphallus undivided; ancorae small and toothlike, distance between them slightly more than the distance between posterior processes of lateral plates; lophi bilobate, outer larger than inner; dorsolateral appendages absent.

Hieroglyphus nigrorepletus Bolivar (Fig. 3I): Same as in *H. banian*, except bridge of epiphallus much widened in the middle; lophi broad and platelike.

Hieroglyphus oryzivorus Carl (Fig. 3J): Same as in *H. banian*, except bridge of epiphallus moderately broad; lophi broad and triangular.

Spathosternum prasiniferum (Walker) (Fig. 3K): Bridge of epiphallus uniformly broad, undivided, posterior margin deeply concave; dorsolateral appendages absent.

Tribe Catantopini

Catantops pinguis (Stal) (Fig. 4A): Bridge of epiphallus continuous, ancorae blunt; lophi lobe-like, close to posterior margin of bridge; dorsolateral appendages absent.

Xenocatantops humilis (Serville) (Fig. 4B): Bridge of epiphallus broad medially; ancorae large, truncated; lophi elongated and transverse; dorsolateral appendages absent.

Catantops karnyi Kirby (Fig. 4C): Bridge of epiphallus narrow, posterior margin U-shaped; ancorae straight, conical; lateral plates with anterior and posterior processes small; dorsolateral appendages absent.

Navasia insularis Kirby (Fig. 4D): Bridge of epiphallus narrow in middle, posterior margin U-shaped; ancorae narrow and curved, distance between them slightly more than the distance between posterior processes of lateral plates; lateral plates with anterior processes triangular; lophi small; dorsolateral appendages absent.

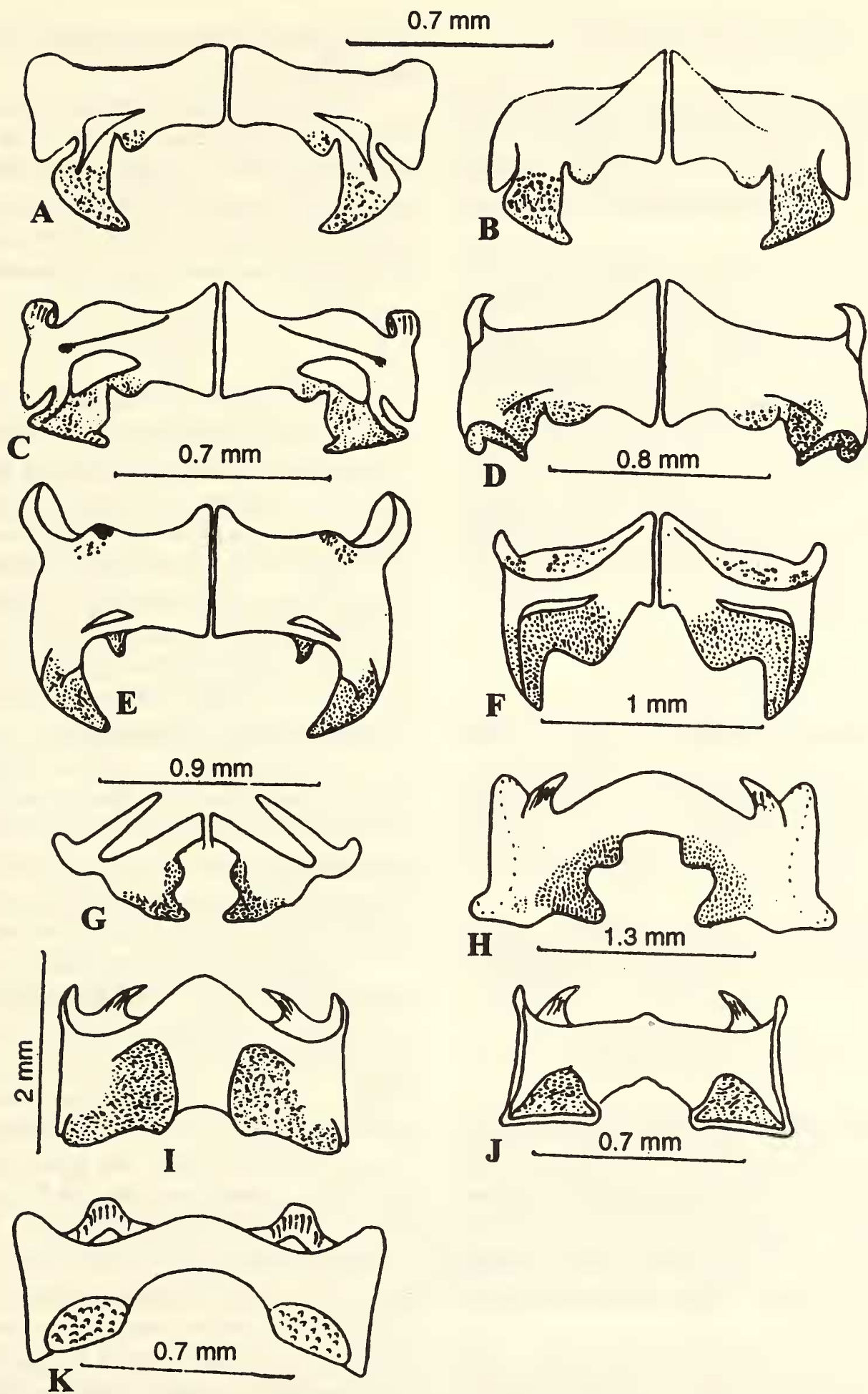


Fig. 3. Figs. (A-K): A. *Oxya hyla* Serville; B. *O. intricata* (Stal); C. *O. fuscovittata* (Marschall); D. *O. chinensis* (Thunberg); E. *O. japonica* (Thunberg); F. *O. velox* (Fabricius); I. *H. nigrorepletus* Bolivar; J. *H. oryzivorus* Carl; K. *Spathosternum prasiniferum* (Walker).

Tribe Cyrtacanthacridini

Cyrtacanthacris tatarica (Linnaeus) (Fig. 4E): Bridge of epiphallus of uniform width; ancorae absent; posterior processes of lateral plates with conical projections; dorsolateral appendages absent.

Pachyacris violascens (Walker) (Fig. 4F): Bridge of epiphallus narrow in the middle; ancorae small, lateral plates with anterior processes small, posterior processes developed; lophi large; dorsolateral appendages absent.

Patanga succincta (Johansson) (Fig. 4G): Bridge of epiphallus narrow in the middle; ancorae absent; lateral plates with anterior processes very small, posterior processes well developed; lophi large and triangular; dorsolateral appendages absent.

Tribe Coptacridini

Eucoptacra binghamii Uvarov (Fig. 4H): Bridge of epiphallus divided medially; ancorae toothlike, distance between them more than half the distance between posterior processes of lateral plates; outer lophi lobe-like; dorsolateral appendages absent.

Eucoptacra praemorsa (Stal) (Fig. 4I): Same as in *E. binghamii*, except lophi crescent shaped.

Tribe Eyprepocnemidini

Tylotropidius varicornis (Walker) (Fig. 4J): Bridge of epiphallus very narrow in the middle, undivided, posterior margin U - shaped; ancorae small, toothlike, with acute apex; lateral plates with anterior processes small, posterior processes indistinct; lophi large; dorsolateral appendages absent.

Heteracris nobilis (Uvarov) (Fig. 4K): Bridge of epiphallus broad, undivided medially; a groove in the middle present; ancorae well developed; lateral plates with anterior and posterior processes small; outer lophi long and

close to posterior margin of bridge; dorsolateral appendages absent.

Eyprepocnemis alacris (Serville) (Fig. 4L): Bridge of epiphallus narrow in the middle, undivided, posterior margin semicircular; ancorae small, hooklike, with acute apex and fused with anterior processes of lateral plates, lophi large, lobiform; dorsolateral appendages absent.

DISCUSSION

Dirsh (1956), Kevan *et al.* (1970, 1971, 1974) treated Pyrgomorphidae, Acrididae and Catantopidae as distinct families on the basis of presence or absence of dorsolateral appendages and ancorae on epiphallus. Kevan *et al.* (1975) and Harz (1975) recognised Pyrgomorphini, Orthacridini, Poekilocerini, Taphronotini, Chrotogonini and Atractomorphini as tribes of the subfamily Pyrgomorphinae; Truxalini, Acridini, Locustini as tribes of the subfamily Acridinae; Oxyini, Hemiacridini, Catantopini, Cyrtacanthacridini, Coptacridini and Eyprepocnemidini as tribes of the subfamily Catantopinae on the basis of the modification of the phallic structures. Eades *et al.* (1974) regarded Atractomorphini as a separate tribe only on the basis of the anchorlike form of the epiphallus.

Similarly, in the present study, dorsolateral appendages ("dorsolateral appendices of epiphallus" of Dirsh, 1956) are present in Pyrgomorphinae (Fig. 1, A-K) and these are absent in the remaining subfamilies i.e. Acridinae (Figs. 2, A-L) and Catantopinae (Figs. 3, A-K, 4A-L). These are good subfamilial characters. Ancorae are absent in Pyrgomorphini (Figs. 1, A-K), Oxyini (Figs. 3, A-G) and Cyrtacanthacridini (Figs. 4 A, E-G) and well developed in the remaining tribes. Bridge of epiphallus is divided medially in Oxyini (Figs. 3, A-G), Coptacridini (Figs. 4, H-I) and undivided in the remaining tribes. These are reliable tribe characters.

It can be concluded that hump - shaped, bridge - shaped, unilobate or bilobate condition

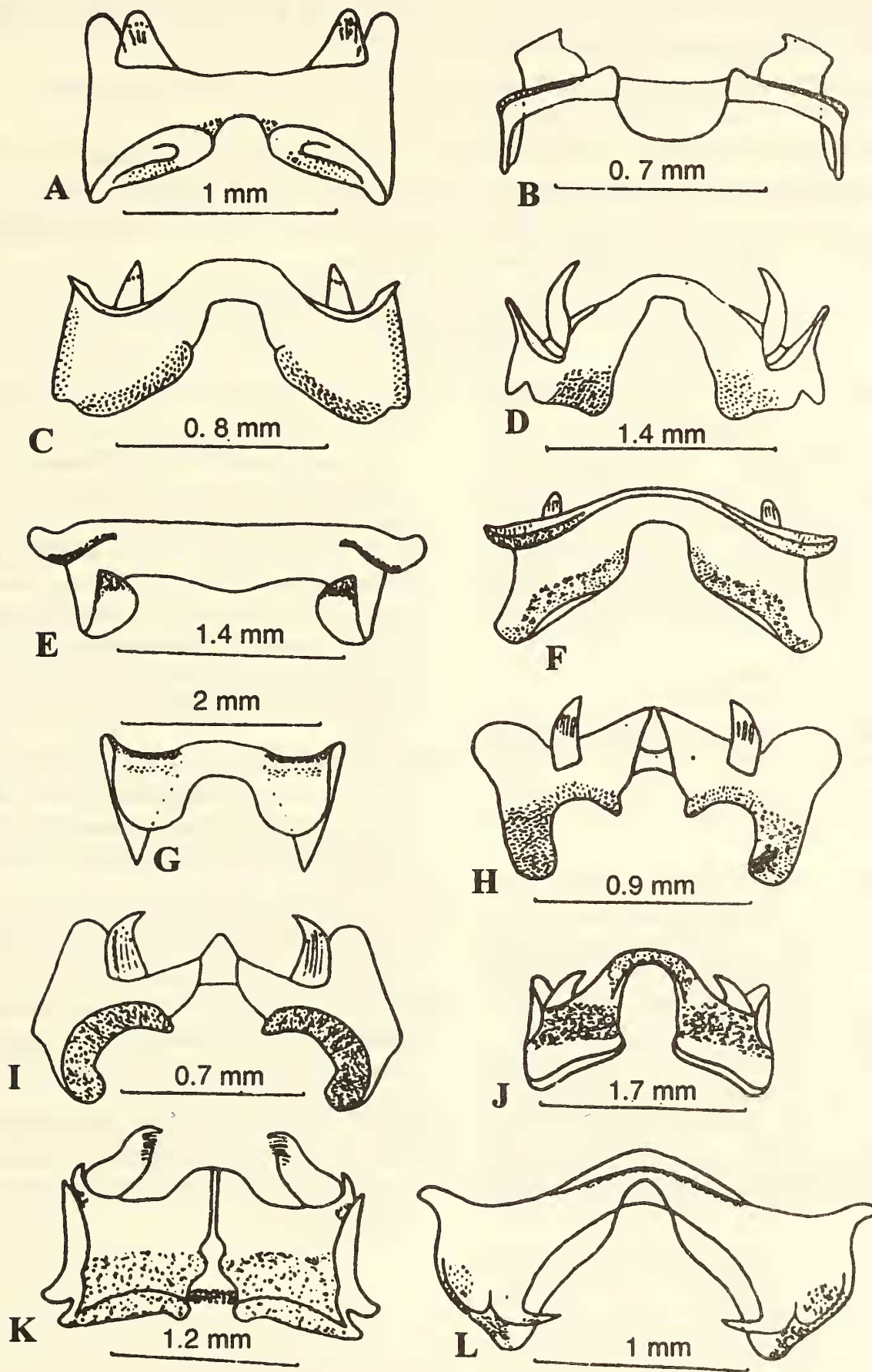


Fig. 4. Figs. (A-L): A. *Catantops pinguis* (Stal); B. *Xenocatantops humilis* (Serville); C. *Catantops karnyi* Kirby; D. *Navasia insularis* Kirby; E. *Cyrtacanthacris tatarica* (Linnaeus); F. *Pachyacris violascens* (Walker); G. *Patanga succincta* (Johansson); H. *Eucoptacra binghamii* Uvarov; I. *E. praemorsa* (Stal); J. *Tylotropidius varicornis* (Walker); K. *Heteracris nobilis* (Uvarov); L. *Eyprepocnemis alacris* (Serville).

of lophi of epiphallus and presence or absence of branch of bridge connecting lophi with bridge are significant generic characters. Moreover, size of anterior and posterior lobes of lophi of epiphallus, and the size and shape of ancorae are stable specific characters. Comparative study of such phallic structures can provide stable taxonomic values for subfamilies, tribes, genera

and species within the family Acrididae.

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